Solar hybrid power systems are hybrid power systems that combine solar power from a photovoltaic system with another power generating energy source. A common type is a photovoltaic diesel hybrid system, combining photovoltaics (PV) and diesel generators, or diesel gensets, as PV has hardly any marginal cost and is treated with priority on the grid. The best business cases for diesel reduction with solar and wind energy can normally be found in remote locations because these sites are often not connected to the grid and transport of diesel over long distances is expensive.

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Optimization of Solar Energy Storage for Hybrid Photovoltaic System

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Optimization of Solar Energy Storage in a Battery for Hybrid Photovoltaic System

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Abstract: *Growing trend of intense usage of electric grids amid rising population, growing development and advancement in solar power generation technology, calls for using solar power as an emergency backup, and storage for non sunlight hours. Solar Panels afre widely used now-a-days which generates energy sufficient for day hours as well excess for storing for usage during night hours. However, Solar Energy so far has not been able to fully replace the conventional energy and thus author draws attention to optimize the storage along with usage of conventional power which is termed here as Hybrid Photovoltaic System. The hybrid system includes the day time usage of Solar power and night time usage of conventional power along with battery storage which stores the access daytime solar power and can be used as an emergency battery backup similar to what we use inverter for. These emergency storage can also be used in any disaster circumstances.*

Keywords: *Hybrid Photovoltaic System, Battery Storage, PV, Renewable, Solar*

INTRODUCTION

Solar PV and related technologies have advanced considerably, but even today diesel gensets continue to dominate disaster relief efforts. This is the time for considering the solar energy when planning for disaster management for vast cities, primarily the areas prone to natural disasters like flood, storms, earthquakes causing severe power outages and damages to vast areas and emergency response needed to save lives [1].

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Solar power is best suited solution for its sustainable and stand-alone capabilities. It is not a question of whether solar power can be used for disaster relief, moreover it is a recommendation to switch to this alternative looking into the other disastrous consequences of depending on generator power and fossil fuel damaging the environmental stability and causing more threats for the disasters. This article intends to explore and identify possible solar applications for disaster relief and preventing power outages during disaster. The community is also interested in having solar powered schools and hospitals which are shelters and life savers during disasters [2].

The study is done by identifying and evaluating widespread solar equipment's which can be used in different situations of disaster mainly to recover the power outage caused by it. The effectiveness of various equipment's is also evaluated from disaster data and statistics available on the scale of damage caused and the amount spent on disaster rescue and relief. In addition, a pilot implementation of DC equipment based solar setup is done in a school which also acts as a shelter during disaster situations [3].

The data and statistics have been collected form the regional and national bodies from the energy and disaster management agencies [4].

RESEARCH ON SOLAR TECHNOLOGIES AND EMERGENCY PLANNING

As of late, there has been some utilization of photovoltaics in emergency requirements as an alternative to diesel generators. They have turned out to be a compelling option in contrast to gas or diesel control generators. PV modules can be a substitute for gas or diesel-controlled generators in a portion of the disaster activities. They are extremely basic frameworks which take into consideration fast reaction to a disaster. Lighting, water treatment, communications and so on are required by the disaster relief specialists to work and these can be quickly met with solar power [10]. The Florida Solar Energy Center (FSEC) and the National Renewable Energy Laboratory (NREL) have been the pioneers on utilizing photovoltaic power for crisis circumstances [11]. They have both created and utilized PV fueled disaster help in the repercussions of disasters. FSEC, for instance, gave PV gear to create control for safe houses and healing centers after tropical storms Andrew and Hugo. NREL has given specialized guidance to the Federal Emergency the executives Administration (FEMA). NREL has given direction on the best way to teach FEMA's staff on the employments of photovoltaics for disaster relief and for building disaster-safe networks.

SOLAR IS THE SOLUTION

As we are aware the fossil fuel is reducing at a very high rate and if we do not switch to other form of energy at this stage, we will leave nothing for our coming generations. Fossil fuel on the earth is finite. People won't be able to burn and derive energy any more beyond the lasting periods which is as close as the following for some of the fuels[17]:

(i) Coal ... 120 years

(ii) Oil .... 250 years

(iii) Nuclear fuel … 200 years

Moreover, how far is it justifiable for the energy packs, which have taken millions of years to form to consume in the next few generations. Just because the future generation is not present to bid today we are claiming our stake on the entire coal blocks and the oilfields.

Solar energy being abundant in nature is a suitable alternative at this stage, since we now have the technology to channelize this solar energy for power generation. Half of the earth is always receiving incessant energy in the form of solar radiation.

Two apparently separate patterns are at present impacting. One is the more extreme and broad harm being perpetrated on electric frameworks amid cataclysmic events, particularly from the inexorably more grounded tempests like tropical storm Maria that crushed Puerto Rico. The second is the numerous innovative advances in solar power age and vitality stockpiling, which additionally lead to progressing cost decreases over the solar esteem chain.

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The possibility of utilizing solar power on an impermanent basis, including for disaster response and relief, isn't new, obviously. Practically, Hurricane Hugo in 1988 is accepted to be the first occasion when the solar power was utilized for recovery in the aftermath of severe disaster. Despite the way that solar PV and related innovations have progressed extensively amid the about three decades from that point forward, diesel gensets keep on commanding disaster aid projects. So, is it at long last time for the solar power industry to emphasize about this developing need?

THE CASE FOR SOLAR

The survey of the World energy resources gives an example of Latin America showing that the renewable energy portion of the energy matrix is reduced, and it is mainly distributed in two generation methods: hydropower and biofuels, representing 36% and 62% of the total renewable energy quota (World Energy Council, 2013) [19].

One concern regarding hydropower is that, besides the impact it generates to the environment, such as microclimate changes and flooding of large areas to create the required dams, it is also difficult to ensure energy continuity, as the availability is directly affected by rain seasons and droughts.

Large hydropower is also responsible of social conflicts, especially in sensitive areas like the jungle of Amazon. During the construction of hydroelectric plant "Tucuruí", in the rainforest of Brazil, about twenty-four hundred square kilometers of rain-forest were flooded, forcing near 30,000 people to leave their territories.

Biofuels are the natural fuels associated with conventional energy consumption for subsistence (like firewood and grass), while the industrial and mechanical forms relate broadly to the production of biofuels like ethanol.

Both traditional and industrial biofuels have been criticized for a variety of reasons. The popularly known is that even though biofuels have a reduced impact in the refining and production processes when compared to conventional, they fail to contribute to reduce industrial greenhouse gases and can lead to deforestation and other non-sustainable practices.

Considering the rainfall rates and the rugged topography of some of the countries, small hydropower plants becomes a good alternative for the supply of electric power, particularly in remote

places. Energy wave along with the tidal wave, together with other different forms of energy found in the sea, opens a huge energy prospect for continents in those areas.

In 2007, Intergovernmental Panel on Climate Change stated that only 12.4% of the total primary energy supply worldwide was delivered from sustainable power sources. Other sources of energy represented: 34% for oil, 26.4% for coal, 20.9% flammable gas and 5.9% nuclear energy [9].

The International Energy Agency (IEA) includes renewable fuels and waste (solid biomass, charcoal, renewable municipal waste, gas and biomass, liquid biomass), hydropower, solar, wind and tide as renewable energy sources, while non-renewable industrial and municipal waste sources are not included as renewable energy.

In developing countries, the solid biomass is by far the largest source of renewable energy, representing 9.3% of global total power energy supply (TPES), or 73% of the worldwide renewable energy source. The second biggest source is hydropower, which gives 2.2% of the worldwide TPES, or 17.7% of renewable energy. Geo-thermal is the third biggest renewable source, much lower, representing 0.4% of the global TPES or 3.3% of the renewable energy supply in the world as per the International Energy Agency, Renewables Information of 2016.

The contribution of the "new" renewable energy sources (solar, wind and tide) for the supply of energy is still very marginal, which represents about 0.2% of global TPES, or the 1.6% of the renewable energy supply. Since 1990, renewable energy sources have grown at an average annual rate of 1.7%. Development has been especially high for wind energy, which grew at a normal yearly rate of 25%. Moreover, this is because of to its very low base in 1990, and the generation is still very less. OECD nations (those belonging to the Organization for Economic Co-operation and Development) record most of the generation and growth of solar and wind energy. Photovoltaic solar energy and thermal solar experienced annual growth rate of 9.8%. The average annual growth rate of hydropower was of 3.7% between 1990 and 2007 in the non-OECD countries and only 0.4% for OECD countries.

Major Environmental and Economic Benefits to the customer include:

- The Solar Plant will generate 3 million kWh over 20 years [20]
- Diesel savings over 20 years will aggregate to 3.5 Lakhs Liters at Gangaganj MSC
- Equivalent to offsetting 2,000 tons of Carbon or taking 400 cars off the road
- Innovative financing solution: combination of part payment, capital subsidy and feed in tariff, with a per unit of cost of delivered electricity being cheaper than blended cost at MSC site of Rs. 9.5/kWh
- Annual Benefit due to Solar Plant - >INR 5 Lakhs / year
- Annual Diesel Savings – 18,000 Liters of Diesel / year
- Land Savings due to utilization of unused roof space & reduction in transmission losses

Time, and not the capacity or the cost, is currently the most basic factor for why solar power manages a suitable, and frequently prevalent, option to gensets for disaster recovery. At the point when quick failover from the electric grid is most critical, for what it's worth for medical facilities, it is hard to compete with backup generators powered by diesel fuel, fluid flammable gas or propane. Indeed, even a medical center on a solar-powered microgrid would almost certainly have a generator for power backup.

At the point when recovery can happen on the magnitude of hours or days, be that as it may, with systems being pulled or flown in, the playing field is currently genuinely level. For systems with a similar size and weight (counting battery stockpiling for the solar framework), the generator will probably have preference as far as kilowatts created. In any case, generators require fuel, which should likewise be pulled or flown in, and once as well as for whatever length of time that power is required.

This need to constantly refuel generators is the thing that gives solar its real favorable position: The more it may take to completely reestablish the electric lattice, the better the case for solar. This is particularly valid for secluded ground mount solar exhibits, which scale more effortlessly and cost-successfully than different designs (secured straightaway). What's more, the more extended the

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recuperation time frame, the more prominent the preferred standpoint solar and storage arrangements appreciate.

SCALING SOLAR POWER

Amid times of disaster reaction, limited requirements for impermanent power can go from 100 watts to 100 kW, and this can likewise be leeway for solar. At the danger of over-improvement, versatile solar frameworks are accessible in four designs: bag, trailer, holder and full cluster. Every ha a task to carry out in various use cases in basically every disaster reaction and recuperation situation.

The bag is perfect for reestablishing interchanges by giving power to both convenient 3G/4G cells and client gadget charging stations. These frameworks, which can likewise be utilized to power some medicinal gear, extend in size from around 50 to 200 watts with somewhere in the range of 10 and 100 amp-long stretches of battery stockpiling.

The run of the mill trailer may have a 5-kW solar cluster and 100-200 kWh of capacity and can be completely operational in under 30 minutes. The higher limits make these reasonable for powering little restorative centers and safe houses.

Delivery compartments are usually used to transport gear and supplies amid disaster aid ventures, and they are additionally perfect for bundling an entire solar plus storage power station. A 20-foot compartment, for instance, could bolster up to 50 kW of power and 500 KWh of capacity to oblige bigger facilities, havens and organizations, just as little lodgings, flats, and water siphons or wells.

Those three frameworks are financially accessible in various sizes to address diverse issues, for disaster alleviation, as well as for transitory/strategic arrangements, for example, those required by the military. What has been missing for solar power is an arrangement that scales more expense adequately, and the convenient and ground mount solar cluster is presently filling this need.

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Making measured ground mount solar exhibits compact and reasonable for disaster reaction and recuperation necessitates that the whole framework—including its establishment—be installable rapidly by little groups utilizing just handheld instruments. The earth stays, which has for some time been utilized by electric utilities for fellow wiring powerline posts, gives the fundamental innovation expected to make such basic establishment conceivable.

For instance, an entire, pre-gathered 5-kW framework, which can be conveyed collapsed on a trailer or truck, or in a delivery compartment, can be introduced by a three-man group in around 60 minutes [21]. The whole framework is similarly as fast and effectively uninstalled (to be "lifted and moved" to another site or put away in anticipation of the following disaster), deserting just the moderately modest earth stays, and those can even be expelled whenever required.

Notwithstanding there for all intents and purposes boundless versatility, these "brief" secluded ground mount solar frameworks have one other favorable position that likewise includes time: They can wind up lasting in appropriated microgrids, even in sea tempest inclined spots like Puerto Rico. Thorough testing in wind burrows has guaranteed a standard earth stay as having the capacity to anchor inspire powers caused by 150 miles-per-hour winds—a class 4 storm. For more noteworthy security, more grounded or potentially extra earth grapples can be utilized.

A CALL FOR ACTION

A generator on its own will be cheaper to begin with, but ongoing fuel costs are hefty, working out in current fuel costs 40p kWh [22]. This means the average house that uses 4,000kWh per year will end up paying £1,600 per year [12]. This is only going to increase. Once solar PV is installed, it will provide free energy for the life of the system, which is well over 30 years. On the off chance that each industry engaged with solar power generation or storage take some initiative in disaster response and recovery activity, regardless of whether alone or in organizations, this wellspring of sustainable power source could put a noteworthy imprint in diesel's predominance. To help with aid ventures in Puerto Rico and demonstrate the suitability of secluded ground mount solar and storage, the solar enterprises gave 10 finish frameworks, each comprising of an Osprey PowerPlatform, 16 solar panels and an Eco Intelligent Battery System (EIBS), alongside any staff assets required. Given that the utilization of diesel and other

non-renewable energy sources adds to storms getting to be more grounded and increasingly visit, it truly is the ideal opportunity for the integration of disaster management with Solar Technology for Disaster Relief.

CONCLUSION

In this way, investigating the developing pattern of progressively serious harm on electric grids amid cataclysmic events, and mechanical advances in solar power generation and power storage, the possibility of utilizing solar power as a crisis reinforcement, including for disaster response and recovery is developing. Solar PV and related innovations have progressed extensively, however even today diesel gensets keep on commanding disaster aid ventures. Anyway, is it at last time for the solar vitality industry to get serious about this developing need? In any disaster circumstance, restoring power winds up a standout amongst the most urgent parts of disaster recovery. rapid-deployment of solar energy could potentially bring quick normalcy in the disrupted lives of the people affected by such calamities. Time, and not the capacity or the cost, is currently the most basic factor for why solar power manages a practical, and regularly prevalent, option to gensets for disaster help. At the point when prompt failover from the electric lattice is basic, all things considered for medical facilities, it is hard to contend with backup generators powered by diesel fuel, fluid gaseous petrol or propane. For portable solar, it isn't important to have solar designers measure the specific site and ascertain explicit solar field positions and arrangements before sending. For instance. Rapid Roll framework is a portable solar innovation which spread out solar panels like a cover from behind a truck with it's high-proficiency solar panels that could help create emergency power in disaster zones, which convey enough solar panels to power a medical facility with 120 beds powering mobile clinics in disaster zones and lessening or wiping out the requirement for non-renewable energy source caravans [18]. At the point when reaction can happen on the request of hours or days, the generator will probably have leverage as far as kilowatts delivered. In any case, generators require fuel, which should likewise be pulled or flown in, and once as well as for whatever length of time that power is required. This need to consistently refuel generators is the thing that gives solar its significant preference: The more it may take to completely reestablish the electric grid, the better the case for solar. Amid times of disaster reaction, restricted requirements for impermanent power can run from 100 watts to 100 kW [23], and this can likewise be favorable position for solar. At the danger of over-improvement, convenient solar systems are accessible in different arrangements i.e. suitcase, trailer, container and full array. Each has a role to play in different use cases in virtually every disaster response and recovery situation. Given that the utilization of diesel and other petroleum products adds to storms getting to be more grounded and frequent, it truly is the ideal opportunity for the solar business to get serious about disaster response and recovery.

FOR UNDER REVIEW

LIST OF ABBREVIATIONS

TW	Terawatt
AC	Alternating Current
DC	Direct Current
KWH	Kilo-Watt Hour
AHr	Ampere Hour
UPS	Un-Interrupted Power Supply
PV	Photo Voltaic
ROI	Return on Investment
UPNEDA	Uttar Pradesh New and Renewable Energy Development Authority
MNRE	Ministry of New and Renewable Energy
SECI	Solar Energy Corporation of India
UPPCL	UP Power Corporation Limited
MW	Megawatt
PV	Photo Voltaic
IOT	Internet of Things
ICT	Information and Communication Technology

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SCOPE OF AND IMPEDIMENTS IN HARNESSING SOLAR ENERGY

(An Inter-Disciplinary approach)

- Shailja Sinha[1], Prof. Manik sinha[2]

Initially power was produced from the fossils like i.e. petroleum, coal, natural gas and Orimulsion, but since these basics are limited and shall exhaust in a near future as per the theories of the experts, we had to look after another elements to harness power. As per an estimate, the World energy consumption is 17.7 TW yearly (One Tera Watt =10^12 =10000000000000 watts) drawn from all resources like oil, coal, natural gas, hydroelectric, wind, bio-gas, nuclear power and solar energy etc. whereas the Sun alone gives 23,000 TW (Tera Watt) power every year, hence it was thought to explore the possibility of harnessing energy from the Sun Radiation. The value of one TW is a power that can illuminate 10 billion bulbs each of 100 watt at the same time spell.[1]

`The entire population of the World consumes power harnessed from all sources available through our technology; there is also a serious implication on our society globally as per the study of International Energy Agency, the U.S. Energy Information Commission and the European Agency[2]. However, we shall discuss this aspect also in this study.

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Now, if we look at the history of 200 years back of our civilization, we will find that there was no mechanical system to produce energy. The only source of energy was burning of wood or plants etc.

Before entering into the discussion of solar energy, let us first go through the long time researches and discoveries done by great scientists and engineers regarding evolution of electricity, which we are using in our modern era. Prior to the discovery of electric light, we were using lamps like lantern illuminated by kerosene oil, candles, torch stick with burning

[1] https://www.theworldcounts.com/stories/current_world_energy_consumption

[2] *"Statistical Review of World Energy (2019)" (PDF). Retrieved 27 September 2019./ "Key world energy statistics" (PDF).* IEA. 2015. *Retrieved 6 April 2017.*and https://en.wikipedia.org/wiki/World_energy_consumption.

materials at one end known in Hindi as *mashal*, a wick in oil or fire. In the history of electricity, the names of three great scientists and engineers namely Thomas Alva Edison, (1847-1931) of America, Serbian-American inventor Nikola Tesla, (1856 – 1943) and George Westinghouse (1846 –1914), an American entrepreneur and engineer based in Pennsylvania have become scientists immemorial...Edison was the first to invent electrical energy apart from mass communication, sound recording and motion picture. Prior to him, the power was generated by gas-light. After about 50 years of continued research by the scientists, finally Edison was able to trump over the era of gas-light system and created electric power. After having become successful in harnessing electric power, he established his own company namely Edison Electric Light Company and made a surprise to the World by manufacturing electric bulb with the use of platinum filament and subsequently by using carbonized bamboo as a source. However, George Westinghouse propounded theory of (Alternating Current) AC current and subsequently Edison merged his company Edison General Electric Company with George Westinghouse's company and became General Electric Company in 1892.Nikola Tesla, the renowned electric and mechanical engineer introduced the idea of DC (Direct Current)[3] who discovered and patented the rotating magnetic field, the basis of most alternating-current machinery.

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While harnessing solar energy, we have to examine the scope of harnessing the energy as well as also to ascertain the legal impediments in this direction.

NUCLEAR POWER

We are aware that the invention of this new technology, we have been producing the energy from different sources like cola, fossils, water and wind, thunder, Tidal Wave Energy, Bio-Gas and Geothermal energy produced from hot springs, subsequently we developed an alternate technology i.e. nuclear thermal power. The concept of nuclear power was initially discovered by our great scientist of the modern India Sir Homi Jahangir Bhabha when India got Independence. In 1950, Bhabha propounded a theory that energy could be produced by

[3] Wikipedia Retrieved on 14.10.2020.

using two elements known as '*uranium*' and '*thorium*' which are found in the sands of coastal areas of South India, which would make India self sufficient to meet its energy requirements. The element *Thorium* in India is around 1-2% of the World's total reserve and the raw material is available free of cost at the sea coasts. India targets to produce 500 GWe[4] for about 400 years which would suffice the need of energy of the country[5].

The principle underlying exploration of Nuclear energy is, as explained above, produced from uranium and thorium, which are used by nuclear fission of uranium and plutonium, nuclear decay and nuclear fusion and these nuclear reactions release nuclear power resulting into heat in turbines which in turn produces electricity. For this purpose a huge power house is maintained.

However, in the face of our requirement for the Nuclear power, the Uranium available is not adequate; hence we have to import Uranium mainly from Russia. Recently the Atomic Minerals Directorate for Exploration and Research, Government of India explored Uranium in Tummalapalla Belt, and uranium mine in Tumalapalli village located in Kadapa of of Andhra Pradesh. One of the largest reserves[6]. P.B. Maithani, Director, Atomic Mineral Directorate for Exploration and research said that 'the potentiality of the area is huge and it will be one of the top 20 of the World's deposits where more than 60,000 tons of uranium is available. He is sure that the uranium deposits will cover the entire length of 160 km of the Tummalapalle belt with a depth consistency of about 400 meters. The uranium recourses found so far can sustain a generation of 5,000 MWe of nuclear power.[7]

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Nuclear Power Plants

The first Nuclear Power generation unit was installed in 1969 in Boisar in Maharashtra named as **Tarapur Atomic Power Plant. The** Nuclear Power Corporation of India Limited (NPCIL), a Government of India Undertaking, at present is operating seven Nuclear energy

[4] **One** megawatt (MW) = 1,000 kilowatts = 1,000,000 watts. For example, a typical coal plant is about 600 MW in size. **Gigawatts** measure the capacity of large power plants or of many plants. **One gigawatt** (**GW**) = 1,000 megawatts = **1** billion watts.

[5] Wikipedia, Retrieved on 14.10.2020.

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plants including 22 operating Reactors.[8] The NPCIL is producing 6780 MWe Nuclear energy. The seven Nuclear Power Plants are as under:

1. Tarapur (Maharashtra), capacity 1,400 MW,
2. Rawatbhata (Rajasthan), capacity 1,180 MW,
3. Kudankulam (Tamil Nadu), capacity 2,000 MW,
4. Kaiga Karnataka capacity: 880 MW,
5. Kakrapar (Gujarat), capacity: 440 MW,
6. Kalpakkam Tamil Nadu. Capacity: 440MW,
7. Narora Uttar Pradesh, capacity: 440 MW.

With the rise of wonderful nuclear science technology and the sufficient availability of raw materials for its production, India stands at the top rank in the Nuclear power production and sufficient to meet the National requirement of energy.

As discussed earlier, initially we had four sources of power generation like coal, gas, hydroelectric and wind, but now with the addition of this new power device, nuclear power system has become the fifths source of energy generating 6,780 MW which is sufficient to meet our requirement,[9] keeping in view of the expected population explosion in the next three decades, the Atomic Energy Commission had planned to raise the target to produce 63 GW upto 2032, but alas, this gigantic idea was to be dropped keeping in view of the tremendous large scale massacre of our civilization which came on account of the nuclear power technology, which ultimately killed 32 million people in Japan apart from 9.0 magnitude earthquake at Tōhoku and tsunami on account of radiation effects emitted from the **Fukushima Daiichi Nuclear Project** in 2011[10] due to radioactive radiation having cancerous effect on the entire human being and the nature in Japan. The impact of the unprecedented

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[8] Hemant Singh - jun 12, 2020 17:45 ist https://www.jagranjosh.com/general-knowledge/list-of-nuclear-power-plants-in-india-1503388974-1#:~:text=tarapur%20atomic%20power%20plant%2d1,installed%20capacity%20of%206780%20mwe. (Retrieved on 14.10.2020).

[9] Tummalapalle uranium mine – Wikipedia/ en.wikipedia.org › wiki › Tummalapalle_uranium_mine (Retrieved 0n 14.10.2020)

[10] www.preventionweb.net › /https://www.preventionweb.net/publications/view/44136#:~:text=Based%20on%20these%20criteria%2C%20approximately,cancer%20non%2Dcancer%20health%20effects..(Retrieved on 14.10.2020/Wikipedia

disaster can be imagined by the fact that just to cool the damaged reactors of the Plant and to melt down the heat from within the contaminated water of the sea were used which will take time upto the year 2022 to cool. The nuclear plant not only killed the millions of the people, destroyed the nature, but also poisoned the Pacific Sea by the radioactive radiation, the effect of which is still being felt. Sabine Charmasson from the French Institute for Radiological Protection and Nuclear Safety (IRSN) says 'Exactly how the water should be dealt with has become highly controversial in Japan, not least because the nuclear disaster caused extreme contamination off the coast of Fukushima. At the time, radioactive water flowed "directly into the sea, in quantities we have never seen before in the marine world.'[11]

Nuclear power in India[12] is the latest technology developed. Initially we started from coal, then moved for gas, then hydro-electric and lastly wind power. Nuclear energy technology is the latest. Initially we commenced with a target of producing 6,780 MW energy, but the target was raised to 63 GW by 2032, but on account of **Fukushima** tragedy, the Government had to painfully withdraw ambitious plan. The Fukushima tragedy brought world-wide tremendous agitation, rejection and opposition of this technology including India, as a result the proposed 9900-MW Jaitpur Nuclear Plant in Maharashtra and the 2000-MW Kundamkulam Nuclear Producing enterprise in Tamil Nadu were dropped. Similarly, the Central government's proposed such plant of 6000 MW at Haripur in West Bengal also came to halt on account of stiff opposition of the West Government. A number of Writ Petitions were also filed in the Supreme Court challenging the justification of installations of such power plants.

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Sri S. P. Udhayakumar, a leading social activist reacting over the installations of such nuclear power projects said: "All over the world people are phasing out or canceling nuclear power plants. Electricity should be for the people. It cannot be at the cost of the people." India has announced plans to raise nuclear power from current 3% total power generated to 25%

[11] dw https://www.dw.com/en/fukushima-how-the-ocean-became-a-dumping-ground-for-radioactive-waste/a-52710277 (Retrieved on 14.10.2020)/

[12] Indiahttps://en.wikipedia.org/wiki/Nuclear_power_in_India/ Wikipedia, the free encyclopedia (Retrieved on 14.10.2020).

by 2050. By 2032 India's nuclear power capacity has been targeted at 63,000 MW from current 4,500MW. [13]

The Fukushima tragedy reminds us the Bhopal Gas tragedy of 1984. The most unfortunate incident that took place on account of leakage of most poisonous Methyl isocynate gas from the pesticide plant of the Union Carbide India Ltd., Bhopal (M.P.) in the night of 2nd and 3rd December, 1984 killing 3,787 people instantaneously and about 25,000 in the next years and about 558125 people injured and 500,000 people were exposed.[14]After the unfortunate tragedy, a Nation-wise agitation was started against the Nuclear power technology. In this agitation not only the peasants and fishermen were at the forefront, rather intellectual class like social activists, journalists, authors, thinkers, professors, scientists and even retired Judges and bureaucrats also took active part, the Government proposed the policy to raise further the nuclear power production to 40 GW. Eminent people like E.A. Sarma, former Power Secretary; T.S.R. Subramanian, former cabinet secretary, Government of India, N. Goplaswami, former chief election commissioner; K.R. Venugopal, former Secretary in the Prime Minister's office; P.M. Bhargava, former Member of the National Knowledge Commission and founder for the Center for Cellular and Molecular Biology; and Admiral Laxminarayan Ramdas, former chief of Naval Staff moved to the Supreme Court assailing the Government's policy on the ground that the impugned Nuclear policy goes against the Fundamental Right to Life guaranteed under Article 21 of the Constitution of India. The Petitioners also challenged the Civil Liability for Nuclear Damage Act, 2010, by capping the financial liability of operators and by making suppliers not liable violates the *'polluter pays'* principle and the *'absolute liability'* principle which have become recognized as part of the law of the land. The Supreme Court has in the past upheld the "polluter pays" and "absolute liability" principles.[15]

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[13] Siddhartha Srivastava-India's Rising Nuclear Safety Concerns:'AS-Asia Sentnel'- Oct 28, 2011/https://www.asiasentinel.com/p/indias-rising-nuclear-safety-concerns (Retrieved on 15.10.2020).

[14] https://www.google.com/search?q=bhopal+gas+tragedy+of+1984&oq=Bhopla+Gas+trajedy+of+1984&aqs=chrome.1.69i57j0i13i457j0i22i30l6.3901j0j8&sourceid=chrome&ie=UTF-8 Retrieved on 15.10.2020

[15] Ranjit Devraj, INSIDECLIMATE NEWS OCT 25, 2011[HTTPS://insideclimatenews.org/news/20111024/india-nuclear-energy-expansion-grassroots-uprising-jaitapur-maharashtra-tamil-nadu-west-bengal-fukushima(Retrieved on 15.10.2020)

SOLAR POWER

Solar power is the fifth and latest technology in order of sequence i.e. from coal, then gas, then hydro-electric then wind power and lastly Nuclear energy. We are aware that the World energy consumption is 17.7 TW yearly (One Tera Watt =10^12 watts) drawn from all resources like oil, coal, natural gas, hydroelectric, wind, bio-gas, nuclear power and solar energy etc. whereas the Sun alone gives 23,000 TW (Tera Watt) power every year. In comparison to the earlier modes of energy production, the solar power technology is the cheapest, because we have not to purchase Sunlight, a great gift of nature to the entire civilization of the world including creatures, atmosphere and agriculture. The unique feature of this technology is that it can be produced by an individual also not only for his domestic purpose rather free also, because the raw basic element i.e. Sunrays are free for all and only installation cost is required which is also not very costly comparing with the recurring cost of electricity purchased by the electricity providers. Apart from generating the power individually and privately and without any intervention from the State authorities or agencies, it can also be generated centrally by the State instrumentalities or agencies on the large scale like the traditional power generating plants to serve a bulk of the society. We are aware that the power generated by the Sunrays, the nature of current is of DC, but it is then converted into AC for its transmission to its Grids wherefrom it is further transmitted to its various Sub-Stations and ultimately to the individual consumers, shops, commercial establishments, industries, schools, colleges, Universities etc like generation. Since the electricity cannot be transmitted on DC current, hence it is initially converted into AC current. However, the individuals generating their own electricity, the nature of current they receive is DC. The technology used , in short, is that Solar panels are installed on the house roofs, which absorbs the Sunrays which is thereafter converted into DC current, which is connected with a Battery, which is then charged by it and from the charged battery, we use the electricity on DC lines.

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The first the solar power plant was initially installed in village Bhadla in Thar Desert situated at about 200 km away from Jodhpur (Rajasthan) fitted with solar panels on an arid stretch **spread over 45 sq km** to produce fuel for Rajasthan's ambitious plan to generate

2,255 MW, making it "the largest solar park in the world". At present it is generating 746 MW and under phase 3 stage it will further generate 1,000 MW power. Similarly, in Pokharan situated in district Jaisalmer in Rajasthan 100-MW solar power plant is in operation. Apart from that several other projects have also been commissioned like Kurnool Ultra Solar Park in Andhra Pradesh and Pavagada Solar Power Park in Karnataka targeting to generate 1000 MW and 2700 MW respectively. The tariff is also very cheap i.e. about Rs. 2.45 per unit. Apart from the cost aspect of the Solar energy, this technology is much more safer than Nuclear technology, whose gigantic catastrophe we have seen in Fukushima tragedy in Japan in 2011.In this way, the Solar power generation technology is by all means safer and cheaper than any other technology.

So far generation of the solar power is concerned; India is at the top in the World. Initially it was producing total 7,568 MW, but it was increased within a period of two years target. At present Rajasthan, Tamil Nadu, Gujarat and Andhra Pradesh are generating 1285.932 MW, 1267 MW, 1120 MW and 864 MW respectively.

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Electricity Sector in India[16]

Sl. No.	Raw material	Production in MW	Percentage
1.	Coal	199,594.5 MW	53.7%
2.	Lignite	6,360 MW	1.7%
3.	Gas	24,991.51 MW	6.7%
4.	Diesel	509.71 MW	0.1%
5.	Nuclear	6,780 MW	1.8%
6.	Large Hydro	45,699.22 MW	12.3%

[16] https://en.wikipedia.org/wiki/Electricity_sector_in_India

7.	Small Hydro	4,712.17 MW	1.3%
8.	Wind Power	37,940.95 MW	10.2%
9.	Solar Power	35,303.3 MW	9.5%
10.	Biomass	10,085.49 MW	2.7%
	Total Energy	3, 71,976.85 MW	**100%**

The above table shows that out of all sources of power production, the highest production comes from Coal i.e. 53.7%, but since Coal production is at the verge of extinction for the purpose of Electricity generation, hence this system is likely to retire from the field sooner or later, so we have to abandon the power production from Coal and the consequent loss of 53.7% of the energy produced from it has to be compensated from other sources and that it is the main concern. Then comes Hydro-electric technology- both large and small totaling to 13.6%, thereafter comes Wind power technology which stands at the fourth place i.e. producing 10.2% and the last but not the least is the Solar energy production which stands at 95% of the total production. The question is that after the exit of Coal production system, we are left with nine systems mentioned in the above table and in that condition which system is to be adopted and in harnessing any other technology, two factor are the main consideration- firstly the safety and secondly the cost of production. Productions from Lignite (1.7%), Gas (6.7%), Diesel (0.1%) and Bio-mass (2.7%) are very limited and we have to abandon these power sectors in the near future. Thus, after excluding Coal, Lignite, Gas, Diesel and Bio-mass; power sectors, we are left with only four sectors- namely, Hydro-electric, Wind, Nuclear and Solar power systems. The Country's largest nuclear power plant was installed at Gorakhpur in (Haryana) by the Nuclear Power Corporation of India Ltd., whose foundation stone was laid by Dr, Manmohan Singh, the then Prime Minister of India on 13th January, 2014 with its installed capacity of 2,800 MW. So far as production from nuclear technology is concerned, the production from this sector is 1.8%, which is very meager. In view of the Fukushima Daiichi massacre and all round agitation against new set ups of nuclear power plants in India not only by the farmers but also the political parties, Parliamentarians, intellectuals like social activists, retired bureaucrats and judges,

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academicians, media and State Governments like West Bengal, Maharashtra etc, the future of nuclear technology is bleak despite the fact that the Government of India had assured that all necessary precautions and safeguards would be ensured so that there may not occur any disaster or adverse effect on the human health, nature or change, but the fact remains that the effect of such project is violative of the Fundamental Rights of the People of India and the same is in contradiction with the principle of Sustainable Development. Thus the nuclear power is presently ruled out. After eliminating nuclear technology, we see that Hydro-electric and Wind technology taken together produce only 23.8%, which is sufficient enough to cater the need of our Country. Thus, after eliminating all the power sectors discussed above, we are left with the solar sector only, which at present gives us only 9.5%, thus, the emphasis is on the solar sector to depend upon.

The unique aspect of this sector is that it can be produced by the individuals also for their domestic consumption that too free of cost, which is not possible in other sectors. It is also generated centrally and transmitted through its Grids to power houses, then to the Sub-Stations and ultimately to the consumers like the individuals as well as for the agricultural, residential, industrial, commercial, educational institutions, roads, parks, train services purposes etc., but the path is not very smooth and it has to face a great hurdle to make its success. Its technology starts from covering a large part of our land, river, canal, barren land etc. by constructing concrete and heavy roofs and thereafter installs the solar panels over such roofs. The individual consumers also have to construct heavy roofs at their house over which the solar panels are installed. Here the danger arises on account of coverage of a large part of the earth depriving Sunrays over it, because by blocking the Sunrays over it, entire environment including the habitats, animals, living creatures over this land and the agriculture and the climate is badly affected, because these radiations are essential for these things.

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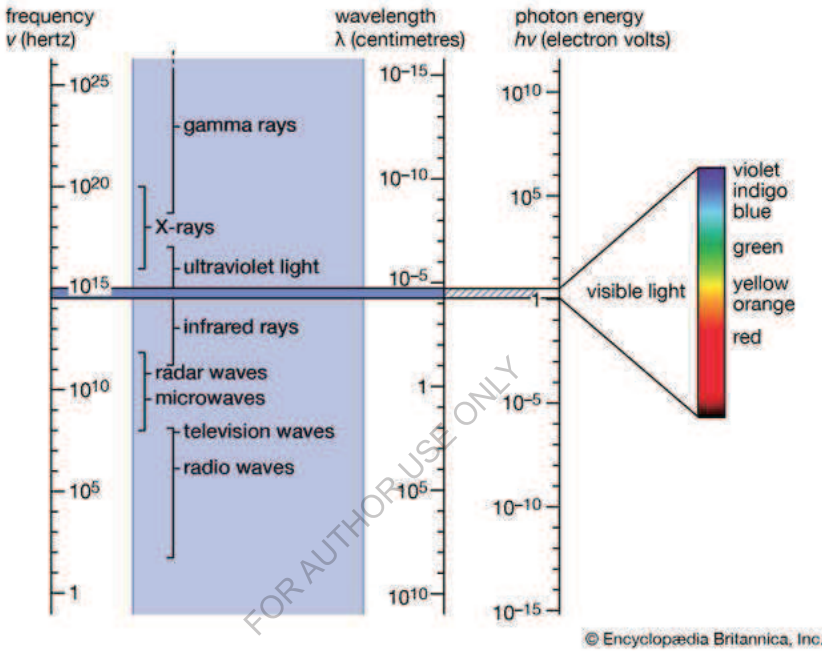
Let us understand the elements that Sun gives us by radiation. They are radio and television, microwaves, radar), Infrared radiation,

visible light, Ultraviolet radiation, X-rays, and Gamma rays. [17] The diagram described by the Encyclopedia Britannica, Inc given below gives a clear picture of frequency, wave-length and photon energy i.e. electron volts.



ELECTROMAGNETIC SPECTRUM.

The narrow range of visible light is shown enlarged at the right. Encyclopædia Britannica, Inc.

By the above illustration, it becomes clear that wherever the open land is covered, the covered portion is deprived of radio waves, television waves, microwaves, radar waves, infra-

[17] . Encyclopedia Britannica, Inc.

red rays, ultra-violet rays, X-rays and Gamma rays. Now let us examine the properties of these waves-

1. **Radio** is the technology of signaling and communicating using radio waves. Radio waves are electromagnetic waves of frequency between 30 hertz (Hz) and 300 gigahertz (GHz). They are generated by an electronic device called a transmitter connected to an antenna which radiates the waves, and received by a radio receiver connected to another antenna. Radio is very widely used in modern technology, in radio communication, radar, radio navigation, remote control, remote sensing and other applications.[18]
2. T**elevision waves** -Electromagnetic **Waves** have different wavelengths. When you listen to the radio, watch **TV**, or cook dinner in a microwave oven, you are using electromagnetic **waves**. Radio **waves**, **television waves**, and microwaves are all types of electromagnetic **waves**. They only differ from each other in wavelength.[19]
3. **Microwaves** are a type of electromagnetic radiation, as are radio waves, ultraviolet radiation, X-rays and gamma-rays. **Microwaves** have a range of applications, including communications, radar and, perhaps best known by most people, cooking[20].
4. **Radar** is a detection system that uses radio **waves** to determine the range, angle, or velocity of objects. It can be used to detect aircraft, ships, spacecraft, guided missiles, motor vehicles, weather formations, and terrain.[21]
5. **Infrared waves**, or **infrared** light, are part of the electromagnetic spectrum. People encounter **Infrared waves** every day; the human eye cannot see it, but humans can detect it as heat. A remote control uses light **waves** just beyond the visible spectrum of light—**infrared** light **waves**—to change channels on your TV.[22]

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[18] https://en.wikipedia.org/wiki/Radio_wave#:~:text=Radio%20waves%20are%20a%20type,as%2030%20hertz%20(Hz).

[19] Electromagnetic Waves - different waves, different wavelengths www.univie.ac.at › site › imagers.gsfc.nasa.gov › ems.

[20] What Are Microwaves? | Live Sciencewww.livescience.com › 50259-microwaves

[21] Radar – Wikipedia-en.wikipedia.org › wiki › Radar

[22] science.nasa.gov › ems › 07_infraredwaves

6. **Ultra–violet rays**- Uses for **Ultra–violet** light include getting a sun tan, detecting forged bank notes in shops, and hardening some types of dental filling. The ultraviolet radiation in sunlight has both positive and negative health effects, as it is a requisite for vitamin D_3 synthesis and a mutagen, a physical or chemical agent that changes the genetic material, usually DNA, of an organism . Hospitals use **Ultra–violet** lamps to sterilize surgical equipment and the air in operating theatres. Food and drug companies also use **Ultra–violet** lamps to sterilize their products. However, Ultra-violet rays are harmful also; it affects the skin, which may even cause cancer.[23]

7. **X-rays** are a type of radiation called electromagnetic waves. X-ray imaging creates pictures of the inside of your body. The images show the parts of your body in different shades of black and white. This is because different tissues absorb different amounts of radiation. Calcium in bones absorbs x-rays the most, so bones look white. Fat and other soft tissues absorb less and look gray. Air absorbs the least, so lungs look black. The most familiar use of x-rays is checking for fractures (broken bones), but x-rays are also used in other ways. For example, chest x-rays can spot pneumonia. Mammograms use x-rays to look for breast cancer.[24]

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8. **Gamma Rays -** Scientists Hassane Erramli Jaouad El Asri [25]**-** in their paper have given the details of their research as under**:**

> "*Gamma rays are high frequency electromagnetic radiation and therefore carry a lot of energy. They pass through most types of materials. Only an absorber such as a lead block or a thick concrete block can stop their transmission. In many alpha and beta transitions, the residual nucleus is formed in an excited state.*

[23] www.darvill.clara.net › emag › emaguv

[24] https://medlineplus.gov/xrays.html#:~:text=The%20most%20familiar%20use%20of,certain%20parts%20of%20your%20body.(Retrieved on 16.10.2020)

[25] Hassane Erramli Jaouad El Asri-Gamma Rays:Applications in Environmental Gamma Dosimetry and Determination Samples Gamma-Activities Induced by Neutrons –IntecOpen Compacts, IntecOpen Limited, 5-Prince Gate Court, London dated 26.6.2019 (Retrieved on 16.10.2020)

Apart from the use of nuclear energy for the supply of electricity, the applications of radioactivity are numerous in many areas: medical physics, earth sciences, industry and preservation of cultural heritage.

The properties used for these various applications are:

Time decline of radioactivity, Radiation emission, Sensitivity of detection and Medical physics applications

The major application of radiation in medicine is radiotherapy and/or treatment by ionizing radiation. A few months after the discovery of X-rays, there is over a century, it has become clear that biological action radiation could be used in the treatment of cancers. Cancers cells divided more quickly are more sensitive, than normal cells to ionizing radiation. By sending these cells a certain dose of radiation, it is possible to kill them and eliminate the tumor.

Sterilization of objects by gamma radiation:

Irradiation of surgical and food material: *Irradiation is a privileged means to destroy micro-organisms (fungi, bacteria, virus…). As a result, many applications radiation exists for sterilization of objects. For example, most medical-surgical equipment (disposable syringes, etc.) is today radio-sterilized by specialized industrialists. Similarly, the treatment by irradiation of food ingredients allows improve food hygiene: sterilization spices, elimination of salmonella from shrimp and frog legs. This technique is also known as food ionization.*

Irradiation of art objects: *Treatment with gamma rays helps to eliminate larvae; insects or bacteria lived inside objects, to protect them from degradation. This technique is used in the treatment of conservation and restoration of arts objects, ethnology and archaeology. It is applicable to different types of materials: wood, stone, leather, etc.*

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Industrial applications

Elaboration of materials: *Irradiation causes, under certain conditions, chemical reactions that allow the development of more resistant materials, more lightweight, capable of superior performance."*

Now let us consider that the area of earth which is required to be covered by the roofs to be built for harnessing the solar energy. As per the report namely "Growth of Electricity in India from 1947-2020" published by the Central Electricity Authority of May 2018 (Retrieved on 28th August, 2019)[26] the surface area of our Country is 3.287 million km² i.e. 32, 87,263 square kilometres. The National Electric Grid of India has capacity to generate 372.693 GW. The net electricity produced was 1,547 TWh[27] and **per capita average consumption of power is 1,181 kWh.** Whereas the 17.89% of the total energy produced is spent on agriculture only.

Rural land area in India was reported to be 29, 80,489 sq km in 2010, according to the World Bank report.[28] Further, out of total land surface, human habitation occupies 8% land, agricultural farms occupy 43% and forests occupy 23% of the total land. Thus, total of habitat and agriculture land come to 51% of total area which roughly comes about more than 1.644 million km² and 833.1 million i.e. 68.4% people live in 64, 08,676 villages.[29] The land surface receives most of its power from the short wavelengths radiated by the sun and in terms of energy, it transmits average 1, 94 calories per sq. cm. per minute in the cloud free climate. Over the Indian land area the "*solar radiation of about 5,000 TW (trillion kWh) per year with average solar power potential of 0.25 kWh/m² of used land area with available commercially proven technologies."*[30] *"As of 31 December 2019, the installed capacity was 33.73 GW, or 2% of utility electricity generation."*[31]

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[26]https://en.wikipedia.org/wiki/Electricity_sector_in_India#cite_note-GES-5(Retrieved on 16.10.2020)

[27] TWh means Tera Watt per hour. One TeraWatt=10,0000,0000.0000 watts .i.e. one trillion watts. Similarly, one GW i.e. Gigawatt=1,000 Megawatt and one Megawatt=1,000 KW and one KW=1,000 watts.

[28]Collection of Development Indicators, India - Rural land area (sq. km) - actual values, historical data, forecasts and projections were sourced from the World Bank on October of 2020.

[29] Census of India, 2011.

[30] https://en.wikipedia.org/wiki/Electricity_sector_in_India#cite_note-mnreSolar-122 (Retrieved on 16.10.2020)

[31] https://en.wikipedia.org/wiki/Electricity_sector_in_India#cite_note-resm-70 (Retrieved on 16.10.2020)

In our Country, there are 64, 08,676 villages spread over 29, 80,489 sq. km area and the village

Population as per the Census for 2019 was 895,386,226.[32]

To work out number of dwelling houses, we have to divide the population by five supposing a family consists of five persons i.e. wife, husband and three children, which comes to 17,90,77,245, so about 18 crores of roof tops are required for solar panel fittings. Although per **capita** average consumption of power is 1,181 kWh.[33] , but by a conservative assessment of power consumption, let us suppose it to be the minimum of only 2 kW and as a thumb rule, 20 Sq meter **area** is required for **2 Kw** capacity **solar** system to generate 1600 watt, which shall be the minimum requirement for 16 hours @ 100 watt per hour.[34] Thus, for 18 crores of dwelling houses, it will require three billion six hundred million (3,600,000,000) sq meter. =3,600 sq km. open space on house top which shall produce 1800 watt per day.[35]

Now let us examine the open land area to be used for production of entire power through solar power system. **India** has established nearly 42 **solar** parks to make for **solar plants**. Rooftop **solar power** accounts for 2.1 GW, of which 70% is industrial or commercial.[36]

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[32] India Rural Population 1960-2020 | MacroTrends/ www.macrotrends.net › countries › IND › rural-population (Retrieved on 20.10.2020)

[33] https://en.wikipedia.org/wiki/Electricity_sector_in_India#:~:text=The%20gross%20electricity%20consumption%20in,having%20a%20low%20electricity%20tariff (Retrieved on 20.1.2020)

[34] 01Kw capacity solar system generates 1600 – 1700 Kwh of electricity per year.
5 things to consider before you plan for a rooftop PV plant .../www.sustainabilityoutlook.in › Articles (trertrieved on 20.10.2020)
1kW Solar System Price in India with Battery & Subsidy - Kenbrook ../.kenbrooksolar.com › system › 1kw-solar-system-pric. (Retrieved on 20.10.2020)

[35] https://kenbrooksolar.com/system/1kw-solar-system-price#:~:text=For%201%20KW%20on%20grid,71%2C442.
During the 2018-19 fiscal year, the gross **electricity** generated by utilities in **India** was 1,372 TWh and the **total electricity** generation (utilities and non utilities) in the country was 1,547 TWh. The gross **electricity** consumption in 2018-19 was 1,181 kWh per https://www.google.com/search?q=total+electricity+is+required+for+india&rlz=1C1JZAP_enIN902IN902&tbm=isch&source=iu&ictx=1&fir=h3YNPP8RFopi0M%252CDiHuwWPvdS33IM%252C_&vet=1&usg=AI4_-kQo8Pi-5pYl0Qn7MTOXESc49dKACA&sa=X&ved=2ahUKEwi_3aS898LsAhUUfH0KHX5TCu0Q_h16BAgKEAc#imgrc=h3YNPP8RFopi0M(Retrieved on 20.10.2020)

[36] https://www.google.com/search?rlz=1C1JZAP_enIN902IN902&biw=1093&bih=500&ei=1ByNX_TXNd2N4-EP2KmpyAo&q=how+many+solar+power+plants+are+there+in+india&oq=How+many+solar+plants+are+there+in+India%3F&gs_lcp=CgZwc3ktYWIQARgAMgYIABAHEB46BAgAEEc6CAgAEAgQBxAeUMtGWPRVYJ5zaABwAngAgAHkAogB6wmSAQcwLjEuMy4xmAEAoAEBqgEHZ3dzLXdpesgBCMAB AQ&sclient=psy-ab/

https://www.google.com/search?q=hydroelectric+power+plants+in+india&rlz=1C1JZAP_enIN902IN902&oq=Hydro-elecytic+power+plants+in+india&aqs=chrome.1.69i57j0i13i457j0i13l2j0i13i30l2j0i10i22i30j0i22i30.23891j0j8&sourceid=chrome&ie=UTF-8

We have the following power plants under different systems:

Sl. No.	Power sector	No. of plants	Area covered
1.	Coal-based (including Lignite fired) Power Stations	33	30 sq/km
2.	Thermal Power Plants	10	20 sq/km
3.	Hydro-electric Power Plants	42	20 sq/km
4.	Wind Power Plants	14	10 sq/km
5.	Geothermal Power Stations from natural hot springs	06	15 sq/km
6.	Nuclear Power Plants	22	10 sq. km
7.	Solar Power Plants	42	40 sq.km.
8.	Tidal Power Station	02	15 sq. km

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Total major operational power plants are 171 leaving aside small plants and power plants under pipeline and construction, thus all such projects taken together come to around 200. Now, if all coal-based, Thermal, Hydro-electric, Wind, Tidal, Geo-thermal and nuclear power plants are replaced by solar system, and then we have to install 200 power stations. Each solar power project requires about 50 sq. km. as such 200 such projects shall require 200x50=**10,000 sq.km.** area of open land to cater the needs for agriculture, irrigation,

horticulture, industries, roads lights, highways lights, railways and entire urban area excluding the villages.[37] And the space required for fitting solar panel roof tops in the villages comes to 3,600 sq km. Thus, total of comes to 10,000+3,600=**13,600** sq.km.[38], whereas India's arable land i.e. land capable of ploughed and used to grow crop area of 159.7 million hectares =15, 97,000 sq/km.[39] and after excluding 13,600 sq km**.** area to be covered by the roof-tops for generating solar energy, the open space comes to 15,83,400 sq.km. Further, on account of urbanization, industrialization, construction of high-ways, development of residential colonies, hospitals, educational institutions the open land of the rural area, the above area of land is also being squeezed day by day. Thus, by day-by-day decreasing area, the agricultural and horticultural productions are the first casualty and it is feared that a day may come when we not be able to provide enough food. Apart from the adverse effect on the agriculture, horticulture and irrigation, we have also to suffer the impact of restricting sunlight over a large area of 13,600 sq km consequently deprivation of radio waves, television waves, microwaves, radar waves, infra-red rays, ultra-violet rays, X-rays and Gamma rays.

According to the experts "

> *"Solar plants with 1.33 million MW capacities could be installed in India on 1% of its land (32,000 square km). Large tracts of land that is unproductive, barren and devoid of vegetation exist in all parts of India, exceeding 8% of its total area. These are potentially suitable for solar power.[40] It has been estimated that if 32,000 square km of these waste lands were used for solar power generation, 2,000 billion kWh of electricity could be produced, twice the total power generated in the year 2013-14. Building solar power plants on marginally*

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[37] https://en.wikipedia.org/wiki/Electricity_sector_in_India#:~:text=The%20gross%20electricity%20consumption%20in,having%20a%20low%20electricity%20tariff.(Retrieved on 20102020)

[38] India It is the seventh-largest country in the world, with a total area of **3,287,263** square kilometres (1,269,219 sq mi). India measures 3,214 km (1,997 mi) from north to south and 2,933 km (1,822 mi) from east to west./Geography of India – Wikipedia en.wikipedia.org › wiki › Geography_of_India (Retrieved on 20.10.2020). Further, Urban land area (sq. km) in India was reported at 222688 sq. Km in 2010, according to the World Bank./https://tradingeconomics.com/india/urban-land-area-sq-km-wb-data.html#:~:text=km)%20in%20India%20was%20reported,compiled%20from%20officially%20recognized%20sources.(Retrieved on 20.10.2020)

[39] The gross irrigated crop area is 82.6 million hectares = 8,26, 000 sq/km.[https://en.wikipedia.org/wiki/Agriculture_in_India#:~:text=India's%20arable%20land%20area%20of,the%20largest%20in%20the%20world.(Retrieved on 19.102020)]

[40] https://en.wikipedia.org/wiki/Electricity_sector_in_India#cite_note-123/ "Wastelands Atlas of India, 2011".(Retrieved on 16.10.2020).

productive lands offers the potential for solar electricity to replace all of India's fossil fuel energy requirements (natural gas, coal, lignite, nuclear fuels, and crude oil."[41]

As per the above expert opinion, for generating 1.33 million MW we require 32,000 square km. land area, which is 1% of the total open land of our country. According to this calculation the total open land comes to 3,200,000 sq. km. However, according to the World Bank data[42] of 2018 it is 29, 80,489 sq. km. Since coal sector is at its extinction stage, hence we are left with other available sectors

Like – Lignite (1.7%), Gas (6.7%), Diesel (0.1%), Bio-mass (2.7%), Hydro-electric technology- (13.6%), Wind power (10.2%) and Solar (9.5%) of the total production but after eliminating all other sectors, we are left with solar technology alone. Thus we have to depend upon it only subject to the conditions laid down for Sustainable Development.

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DISADVANTAGES FROM POWER GENERATION SECTORS

Lignite- Exposure to it increases for example the risks for lung cancer, chronic bronchitis, ischemic heart attack, and heart arrhythmia and heart insufficiency.[43]

Gas- The drilling and extraction of natural gas from wells and its transportation in pipelines results in the leakage of methane, primary component of natural gas that is 34 times stronger than CO2. Unconventional gas development can affect local and regional air quality. Some areas where drilling occurs have experienced increases in concentrations of hazardous air pollutants and two of the six "criteria pollutants" — particulate matter and ozone plus its precursors — regulated by the EPA because of their harmful effects on health and the environment. Exposure to elevated levels of these air pollutants can lead to adverse health outcomes, including

[41] https://en.wikipedia.org/wiki/Electricity_sector_in_India#cite_note-125/"How the world's largest solar park is shaping up in Karnataka". (Retrieved 16.10.2020)

[42] https://tradingeconomics.com/india/land-area-sq-km-wb-data.html#:~:text=km)%20in%20India%20was%20reported,compiled%20from%20officially%20recognized%20sources.

[43] Health impacts of lignite-fired power plants - Health ;pdf/www.env-health.org › wp-content › uploads › 2018/06 (Retrieved on 18.10.2020)

respiratory symptoms, cardiovascular disease, and cancer. The construction and land disturbance required for oil and gas drilling can alter land use and harm local ecosystems by causing erosion and fragmenting wildlife habitats and migration patterns. Unconventional oil and gas development may pose health risks to nearby communities through contamination of drinking water sources with hazardous chemicals used in drilling the wellbore, hydraulically fracturing the well, processing and refining the oil or gas, or disposing of wastewater.[44]

Diesel- Diesel generators produce substantial amount of greenhouse gases and harmful air pollutants including black carbon (BC), carbon monoxide (CO), nitrogen oxides (NOx), sulphur dioxide, hydrocarbons (HC), and particulate matter (PM).[45]

Bio-mass- The biomass burned can emit more pollution than fossil fuels. Unlike carbon dioxide emissions, many of these pollutants cannot be sequestered by new plants. These compounds can lead to a number of environmental and human health issues if not properly contained. [46]

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Hydro-electric- The hydropower projects have several impacts on the environment. Water quality decline is one of the impacts of hydropower and water quality may be affected around a hydropower plant. Water discharged from a reservoir can be of a different composition to the water that is flowing into a reservoir. The other impacts of hydropower plant are migrations barriers. Hydropower dams impede the flows of rivers and thereby affect the habitat of various aquatic lives. Migratory animals require different environments for their different phases of their life cycle. Different stages are reproduction, production of juveniles, growth and sexual maturation. These different stages take place in different environments for different fishes. Even if hydropower is a renewable energy source it is not an energy source without GHG emissions. Greenhouse gas emissions can occur at three different phases hydropower plant (the construction, the operation and maintenance and the

[44] REPORTS & MULTIMEDIA / EXPLAINER: Environmental Impacts of Natural Gas, Published Jun 19, 2014/https://ucsusa.org/resources/environmental-impacts-natural-gas (Rtrieved on 18.10.2020).

[45] Diesel Generator - an overview | ScienceDirect Topics/www.sciencedirect.com › topics › engineering › diesel-generators#:(Retrieved 18.10.2020).

[46] Environmental Impacts of Biomass | EnergySage/www.energysage.com › about-clean-energy › environment.(Retrieved on 18.10.2020).

decommissioning of the plant). During the construction phase the emissions comes from the production and transport of the materials needed for the construction and from the work equipment.[47]

Wind - Wind energy has a similar drawback to solar energy in that it is not constant. **Wind Turbines** Are Expensive. Although costs are reducing, **wind turbines** are still very expensive, Pose a Threat to Wildlife are Noisy. .

Wind Turbines Create Visual Pollution and adverse environmental impact

Wind turbines blades are very large and rotate at very high speeds. Unfortunately, their blades can harm and kill species that fly into them, like birds and bats. The construction of wind farms can also disrupt natural habitats of local species if not conducted in a sustainable manner. However, these problems can be solved to some extent with technological advancements and properly-sitting wind farms.

Pierpont documented **symptoms** reported by individuals exposed to **wind turbines**, which include sleep disturbance, headache, tinnitus, ear pressure, dizziness, vertigo, nausea, visual blurring, tachycardia, and irritability, problems with concentration and memory, and panic episodes associated with sensations of internal[48] .

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Solar –The sun is a tremendous source of renewable energy. Nevertheless, the adverse effects of solar power are associated with land use, water use, habitat loss, and the harmful materials used in manufacturing of solar panels. To build a utility-scale solar power facility, a large area of land is required. This can interfere with the existing land uses. The use of many acres of land can result in clearing and grading of land, which can cause soil compaction, erosion, and alteration of drainage channels. Furthermore, solar energy systems

[47] Environmental Impacts of Hydropower and Alternative Mitigation Measures: Current Investigations in Agriculture and Current Research Volume 2 - Issue 2/ https://lupinepublishers.com/agriculture-journal/fulltext/environmental-impacts-of-hydropower-and-alternative-mitigation-measures.ID.000133.php Mohammed Mussa1*, Habtamu Teka1 and Hussein Ayicho2
1Department of Animal and Range Science,
2Department of Geography and Environmental Science, Madda Walabu University, Ethiopia
Corresponding author: Mohammed Mussa, Department of Animal and Range Science, Madda Walabu University, Ethiopia April 20, 2018(Retrieved on 18.10.2020)

[48] Adverse health effects of industrial wind turbines – NCBI/www.ncbi.nlm.nih.gov › pmc › articles › PMC3653647(Retrieved on 18.10.2020)

can impact the land in the process of materials extraction, exploration, manufacturing, and disposal.

The land use and habitat loss, water use, and the use of hazardous materials in manufacturing—which includes two broad categories: **photovoltaic (PV)** solar cells or **concentrating solar thermal plants (CSP),** PV and CSP projects—also plays a significant role in the level of environmental impact. It also raises concerns about land degradation and habitat loss. There is less opportunity for solar projects to share land with agricultural uses. Concentrating solar thermal plants, like all thermal electric plants, require water for cooling. Water use depends on the plant design, plant location, and the type of cooling system.

Concentrating solar thermal plants that use wet-recalculating technology with cooling towers withdraw between 600 and 650 gallons of water per megawatt-hour of electricity produced. The PV cell manufacturing process includes a number of hazardous materials, most of which are used to clean and purify the semiconductor surface. These chemicals, similar to those used in the general semiconductor industry, include hydrochloric acid, sulfuric acid, nitric acid, hydrogen fluoride, 1,1,1-trichloroethane, and acetone. Thin-film PV cells contain a number of more toxic materials than those used in traditional silicon photovoltaic cells, including gallium arsenide, copper-indium-gallium-diselenide, and cadmium-telluride. These materials could pose serious environmental or public health threats.[49]

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We have discussed the side effects of all the technologies for the generation of power and we have found that there is not a single sector which is free from any side effect. Thus, we have to choose such technology for the purpose of producing current which may be of least side effects, easy to harness energy and cheaper for its consumption and a lasting

[49] Union of Concerned Scientists/REPORTS & MULTIMEDIA / EXPLAINER/Environmental Impacts of Solar Power/ https://www.ucsusa.org/resources/environmental-impacts-solar-power#:~:text=The%20potential%20environmental%20impacts%20associated,solar%20thermal%20plants%20(CSP) Mar 5, 2013(Retrieved on 18.10.2020)

technology, so that we may not go to search or innovate any other source of power production. Perhaps keeping in view of these alternatives, the Government of India has innovated the idea of creating solar energy despite the fact that it has also severe adverse effects on humanity, agriculture, vegetation, climate, nature and environment.

SOLAR RADIATION MANAGEMENT (SRM)

It is a branch of technology dealing with the climate change. The basic principle of this technology is that because of sunlight on the earth more than enough heat is generated which cause adverse effect on human being and the animals and the environment during summer season like sun-burn, damage and burning of agricultural and horticultural products, early decay of eating materials, evaporation of water from the rivers, canals etc. This heat adversely affects the climate in summer season. With a view to meet this challenge, a new technology was developed to manage and control the sun-rays or sun radiation falling on the earth. This technology is names as 'Solar Radiation Management' in short referred to as 'SRM' or Geo-engineering. By this technology the sunrays are reflected back by spaying sulphur-dioxide or hydrogen sulphide into the upper region of the atmosphere by a highly developed scientific technique through billions of balloons in the space and designing clouds technically known as 'startosphere'. The solar radiation is controlled from falling on the earth and a vast portion of the solar radiation are reversed back to the sun is diffused by certain chemical reactions and using certain elements to reverse the radiation back in order to reduce the excessive heat particularly during summer period. Restring solar radiation for the purpose of harnessing solar power also comes with the purview of SRM.

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According to the Climate Engineering scientists the SRM can be summarized below as below:[50]

50 https://www.google.com/search?q=Solar+radiation+management+(SRM)+is+a+type+of+climate+engineering+in+which+sunlight+(solar+radiation)+is+reflected+to+limit+or+reverse+global+warming.&rlz=1C1JZAP_enIN902IN902&oq=Solar+radiation+management+(SRM)+is+a+type+of+climate+engineering+in+which+sunlight+(solar+radiation)+is+reflected+to+limit+or+reverse+global+warming.&aqs=chrome..69i57.1845j0j8&sourceid=chrome&ie=UTF-8(Retrieved on 22.10.2020)

"It is a type of climate engineering in which sunlight (solar radiation) is reflected to limit or reverse global warming. Proposed methods include increasing the planetary albedo (albedo is the measure of the diffuse reflection of solar radiation out of the total solar radiation through a black body (A ***black body*** *or* ***blackbody*** *isanidealized physicalbody that absorbs all incident electromagnetic radiation, regardless of frequency or angle of incidence. The name "black body" is given because it absorbs radiation in all frequencies*,) *that absorbs all incident radiation) for example using stratospheric sulfate aerosols. Restorative methods have also been proposed regarding the protection of natural heat reflectors including sea ice, snow, and glaciers. ……. SRM would not reduce greenhouse gas concentrations in the atmosphere, and thus does not address problems such as ocean acidification caused by excess carbon dioxide (CO_2).*

However, the scientists have also warned about its side effects Side effects and accordingly:[51]

"There may be unintended climatic consequences of solar radiation management, such as significant changes to the hydrological cycle that might not be predicted by the models used to plan them.[23] Such effects may be cumulative or chaotic in nature. Ozone depletion is a risk of techniques involving sulfur delivery into the stratosphere."

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PROHIBITION IMPOIOSED BY WORLD BODIES

U.N. Environmental Modification Convention-Geneva (Switzerland)-1977: The Environmental Modification Convention, formally the Convention on the Prohibition of Military or Any Other Hostile Use of Environmental Modification Techniques is an international treaty prohibiting I It is ratified by 48 countries any technique for changing -- through the deliberate manipulation of natural processes -- the dynamics, composition or

[51] https://en.wikipedia.org/wiki/Unintended_consequences.Retrieved on 20.10.2020)

structure of the Earth, including its biota, lithosphere, hydrosphere and atmosphere, or of outer space.[52]

The **Brundtland Commission** was constituted in 1983 with a view to unite the World to work together for balancing the social development and the protection of nature both. The emphasis was that all Nations to enter into a treaty to the effect that whatever development takes place in the member States , by doing this, they shall not adversely affect the nature, its environment, natural resources and its climate and for this purpose object was named as 'Sustainable Development.' This Commission was constituted in term a resolution passed by the United Nations General Assembly in 1983.

Montreal Protocol - The Montreal Protocol on Substances that Deplete the Ozone Layer, also known simply as the Montreal Protocol, is an international treaty signed on 26th August, 1987 and ratified by 46 Nations designed to protect the ozone layer by phasing out the production of numerous substances that are responsible for ozone depletion.[53]

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KYOTO PROTOCOL

The United Nations in 1992 passed a resolution to meet out the challenges being faced by the member State regarding Green House Gas (GHG) emission problem and as follow up action a convention of member States was held 11th December, 1997 at KYOTO (Japan) and it was resolved to impress upon the member nations to commit for taking all necessary efforts GHG emissions on their part to reduce GHG emissions and manmade carbon-dioxide explosion and the participating Nations entered into a treaty, which was ratified by 192 Nations. This is known as TYOTO Protocol.[54]

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[52] https://2009-2017.state.gov/t/isn/4783.htm. Retrieved on 22.102020)

[53] www.environment.gov.au › protection › montreal-protocol. (Retrieved on 22.10.2020)

[54] https://en.wikipedia.org/wiki/Kyoto_Protocol#:~:text=The%20Kyoto%20Protocol%20was%20adopted%20at%20the%20third%20session%20of,exclude%20international%20aviation%20and%20shipping.Retrieved on 22.102020)

CONVENTION ON BIOLOGICAL DIVERSITY

A Convention on Biological Diversity was held at Rio de Jenerio, Brazil held in 1992 with a view *'to conservation of the biological diversity, the sustainable use of its components, and the fair and equitable sharing of benefits arising from genetic resources'* and for this purpose a world treaty was adopted which was ratified by 196 Nations and was made effective from 29th December, 1993.

The Convention on Biological Diversity, known informally as the Biodiversity Convention, is a multilateral treaty. The Convention has three main goals: the conservation of biological diversity; the sustainable use of its components; and the fair and equitable sharing of benefits arising from genetic resources.[55] Its objective is to develop national strategies for the conservation and sustainable use of biological diversity, and it is often seen as the key document regarding sustainable development. The concept of sustainable development is that State may utilise all its knowledge and technology for the development of the society, its people and the animals, agriculture, plants, micro-organism, species, genetic resources and the eco-system etc., but in doing this the State cannot adversely disturb the nature. It must ensure that in *'meeting human development goals while simultaneously sustaining the ability of natural systems to provide the natural resources and ecosystem services on which the economy and society depend. The desired result is a state of society where living conditions and resources are used to continue to meet human needs without undermining the integrity and stability of the natural system. Sustainability goals address the global challenges, including poverty, inequality, climate change, environmental degradation, peace and justice'.*

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ADVERSE EFFECT OF SRM

The American Institute of Aeronautics and Astronautics (AIAA), Reston, Fairfax County, Virginia, has given its findings both on the negative and positive aspects of Solar

[55] [https://en.wikipedia.org/wiki/Convention_on_Biological_Diversity.Retrieved 20.10.2020)].

Radiation Management or Geoengineering, the field which also includes harnessing of Solar energy. The finding is detailed below:

Some of the adverse effects are unknown and unexpected consequences, continued ocean acidification, worsens Ozone depletion, less sun for solar power , environmental impact of implementation of noise, emission, pollution and debris , white instead of Blue Sky, ruins terrestrial optical astronomy, ruins much of Satellite Remote Sensing, impact on Respiratory health, Disruption of Monsoons, Changes/Reduction in Global Precipitation, more Acid deposition, potentially greater tropospheric (heat absorbing) cirrus cloud formation.[56]

Tingzhen Ming and Renaud de_Richter, the Scientists of Solar and Power Engineering at the Huazhong University of Science and Technology, Wuhan (China) and Institute Charles Gerhardt Montpellier, Cedex 5, France respectively have struck a note of caution as under:[57]

> *"By pumping massive amounts of CO_2 and other GHGs into the atmosphere and by building mega-cities and thousands of kilometers of black paved highways, humans have already engaged in a dangerous geophysical experiment. The only difference with CE is that it was unintentional. The best and safest strategy for reversing climate change is to halt this buildup of atmospheric GHGs and stop CO_2 emissions, but this solution will take time, and it involves a myriad of practical and political difficulties. Meanwhile, the dangers are mounting and even with a serious effort to control GHGs emissions, meaningfully reducing them in the very near term is an unattainable goal.*
>
> *It is worth noting that since 1977 there is an Environmental Modification Convention, which has so far been ratified by 76 countries. It prohibits*

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[56] Alan Robock-' 20 Reasons why geoengineering may be a bad idea': Bulletin of the Atomic Scientists, Vol. 64, No. 2 pp. 14-19 May-June, 2008. https://www.google.com/search?q=Bulletin+of+the+Atomic+Scientists%2C+Vol.+64%2C+No.+2+pp.+14-19+May-June%2C+2008&rlz=1C1JZAP_enIN902IN902&oq=Bulletin+of+the+Atomic+Scientists%2C+Vol.+64%2C+No.+2+pp.+14-19+May-June%2C+2008&aqs=chrome..69i57.2833j0j8&sourceid=chrome&ie=UTF-8 (Retrieved on 16.10.2020)

[57] Tingzhen Ming (1) Renaud de_Richter (2) =(1) School of Energy and Power Engineering, Huazhong University of Science and Technology, Wuhan 430074, China (2) Institute Charles Gerhardt Montpellier − UMR5253 CNRS-UM2 − ENSCM-UM1 – Ecole Nationale Supérieure de Chimie de Montpellier, 8 rue de l'Ecole Normale, 34296 Montpellier Cedex 5, France-Fighting global warming by climate engineering: Is the Earth radiation management and the solar radiation management any option for fighting climate change? **SCIENCEDIRECT**-ELSEVIER-Renewable and Sustainable Energy Reviews: Volume 31, March 2014, Pages 792-834= https://www.sciencedirect.com/science/article/pii/S1364032113008460#! (Retrieved on 22.102020)

the hostile use of techniques that modify the dynamics, composition, or structure of the Earth (including the atmosphere) or of outer space. ……..Also, till date the most successful international agreement of 1987 *is the* Montreal *Protocol on Substances that Deplete the Ozone Layer*." *All UN recognized nations have ratified the treaty and continue to phase out the production of chemicals that deplete the ozone layer…….. Moreover, they would not eliminate the cause of climate change, the emissions of GHGs and the associated threat of ocean acidification. For many experts the whole idea of pursuing these "technical fixes" is controversial since SRM can probably restore on average the Earth's global radioactive balance, but regional climate discrepancies will remain."*

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Another researcher in the field of Renewable energy Ms. Pradhnya Tajne [58] observes as under:

"The sun is a tremendous source of renewable energy. Nevertheless, the adverse effects of solar power are associated with land use, water use, habitat loss, and the harmful materials used in manufacturing of solar panels. To build a utility-scale solar power facility and a large area of land is required. This can interfere with the existing land uses. The use of many acres of land can result in clearing and grading of land, which can cause soil compaction, erosion, and alteration of drainage channels. Furthermore, solar energy systems can impact the land in the process of materials extraction, exploration, manufacturing, and disposal……

[58] Pradhnya Tajne-The Dark Side of Renewable Energy: Negative Impacts of Renewables on the Environment- Transparency Market Research/.https://www.altenergymag.com/article/2015/08/the-dark-side-of-renewable-energy-negative-impacts-of-renewables-on-the-environment/20963/(Retrieved on 21.10.2020)

This shows how renewables can negatively impact the planet. However, renewables are making a notable difference in the world as they are helping to curb carbon emissions. What scientists, engineers, companies, and nations expanding their power capacities need to focus on, is implementing solutions that keep negative impacts of renewables in check. For example, instead of building solar power stations by clearing a piece of land, homes and buildings can be equipped with individual solar panels on a large scale."

SUSTANABLE DEVELOPMENT & LEGAL IMPEDIMENTS

"Earth provides enough to satisfy every man's needs, but not every man's greed." - Mahatma Gandhi

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We have discussed that several treaties were executed by the member Nations of the United Nations guaranteeing for the maintaining Sustainable Development so that the environment may not be adversely affected and for this purpose the Nations bound themselves that they shall not undertake any such scientific or technological pursuits particularly in the space, ocean, environment, ecology and climate for the purpose of development which may destroy its existence. The first such U.N. Convention was called in the year 1972 at Stockholm for maintain Sustainable Development; thereafter in 1977 **U.N. Environmental Modification Convention-Geneva (Switzerland) was held**. Then came the Bruntland Commission in 1983 and thereafter Montreal Protocol was signed in 1987 when depletion of the Ozone Layer was detected in the sky, a very dangerous incident, which causes 2-3% increase of skin cancer. After the Bruntland Commission, Biological Diversity convention was held in 1992 for the conservation of Biological diversity and genetic resources and finally in 1997 a U.N. Convention was held at Kyoto (Japan) regarding Green House Gas (GHG) and other poisonous gas emission problem. In all such conventions, treaties were signed by the member Nations, which adopted the treaties and gave to themselves to it. The U.N. Convention held at Kyoyo is popularly known

as the 'Kyoto Protocol.' Thus, all the treaties are legal documents and the member Nations are bound to follow the mandates of the aforesaid treaties.

Under such circumstances, no Nation can undertake any scientific or technological pursuit in violation of the above treaties. Our Constitution envisages that any Inter-National treaty made through the intervention of U.N.O. had legal sanction and this form part of International law. Our Supreme Court in a catena of cases has upheld the aforesaid treaties and laid down the law that State is bound the treaties in letter and spirit and no one can be permitted to contravene the provisions of such treaties and held that the violators have to pay the cost of creating pollution and for its restoration and coined a term as '*Polluter Pays'.*

Our Supreme Court has upheld the provisions of the treaties referred to above in regard to Sustainable Development as a basic feature of our Constitution by means of a catena of cases and laid down a law that no one is permitted to violate the terms of the treaties in this regard. It further said that whoever contravenes it, shall be liable to pay cost for the damage done as well as further cost for the restoration of Nature.

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In the case of *Vellore Citizen Welfare Forum v. Union of India*[59], the Supreme Court, while directing the closure of 162 tanneries, which were polluting the area and had not complied with the directions of the Court to set up the pollution control devices within the time prescribed, held that

> "*Remediation of the damaged environment is part of the process of 'Sustainable Development' and as such polluter is liable to pay the cost to the individual sufferers as well as the cost of reversing the damaged ecology.*"

[59] (AIR 1996 SC 2715)

In another case *Narmada Bachao Andolan v. Union of India*[60], the Apex Court observed that scientific and technological development can be permitted only within the prescribed limits and not beyond. The Court held:

> *"Sustainable Development means what type or extent of development can take place, which can be sustained by nature or ecology with or without mitigation".*

In *T.N. Godavaraman Thirumulpad v. Union of India*[61], the Hon'ble Supreme Court said

> *"We may state that adherence to the principle of Sustainable Development is now a constitutional requirement. How much damage to the environment and ecology has got to be decided on the facts of each case"?*

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Similarly, in the case of *Indian Council of Enviro-Legal Action vs. Union of India*[62], the fact of the case was that the industries in question were producing certain chemicals like oleum and hydrochloric acid etc. which these factories were discharging highly toxic effluents resulting in pollution of ground water and making it unfit for drinking by human beings, cattle and for irrigating the land. The affected soil became unfit for cultivation, the Apex Court held:

> "*While economic development should not be allowed to take place at the cost of ecology or by causing widespread environment destruction and violation; at the same time, the necessity to preserve ecology and environment should not hamper economic and other developments*".

In the case of *F.B. Taraporewala and Others v. Bayer India Ltd. and Others*[63] , the Top Court of held as under:

[60] (2000) 10 SCC 664
[61] (2008) 2 SCC 222
[62] 1996 (5) SCC 281
[63] 1996 (6) SCC 58

"An Industrial Growth- Yes: but by exposing a large segment of society to the risk of lives, no. This apprehension is not imaginary. Bhopal disaster brought to the knowledge of all what a tragedy can be caused by chemical industries. In the wake of what happened there more than a decade ago, industrialists engaged in producing chemicals started thinking of taking precautionary and protective measures to see that if worst were to befall, how could their financial liability be taken care of. The Hon'ble Supreme Court of India further observed that the concept of sustainable development does call upon one and all to see to the maintenance of balance between development and its sustenance in future."

Hence, importance has been given both to development and environment and the quest is to maintain a fine balance between environment and economic development.

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The Constitutional aspect of sustainable development finds place in our Constitution and in International Covenants and Treaties:

"Article 48-A of our Constitution reads as under:-

'The State shall endeavor to protect and improve environment and to safe guard the forest and wildlife of country.'

Article 51-A casts a duty on every citizen of India to protect and improve the natural environment including forest, lakes, rivers, wildlife and to have compassions for living creatures. In terms of the aforesaid mandates, the Parliament enacted important legislations to meet the crisis of ecological imbalances.

The U.N. Inter-National Conference on the protection of environment was held at Stockholm, in which the environment is viewed more as resource basis for survival of the present and future generations, thus it resolved that:

'Man has the fundamental right to freedom, equality and adequate conditions of life, in an environment of quality that permits a life of dignity and well-being, and he bears a solemn responsibility to protect and improve the environment for present and future generations, and

'The natural resources of the earth, including the air, water, lands, flora and fauna and especially representative samples of natural ecosystems, must be safeguarded for the benefit of present and future generations through careful planning or management, as appropriate.'

The United Nations taken an initiative by organizing U.N. Conference on Human Environment at Stockholm in 1972, which was attended by the 192 World leaders in which principle of sustainable development was unanimously adopted, which was reiterated in the year 2002 in the Johannesburg Summit on Sustainable Development.

Thus the need of the hour is that we have to fight at both fronts by continuously doing researches in the field of Clean Energy Technology and developing laws to balance the equilibrium between industrialization, Urbanization, Modernization and Development in field of Science, Technology, Electronics, I.T. Agricultural modernization etc.

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Prof. Manik Sinha, former Dean of the Faculty of Law, Dr. Ram Manohar Lohia Avadh University, Ayodhya and Senior Advocate, Allahabad High Court, Lucknow Bench, Lucknow [64] analyzing the Constitutional aspects and various case laws on this issue propounded by the Supreme Court of India observes as under:

"*This therefore, is the aim, namely, to balance economic and social needs on the one hand with environment considerations on the other. But in a sense all development is an environmental threat. Indeed, the very existence of humanity and the rapid increase in the population together with consequential demands to sustain the population has resulted in the concreting of open lands, cutting down of forests, the filling up of takes and pollution of water resources and the very air which we breathe. However, there need not necessarily be a deadlock*

[64] National Journal of Comparative Law-2015 Vol.2 Issue 1 pp.54/ Speech delivered as a Special Guest at the National Seminar organized by Dr. R.M.L. Avadh University, Ayodhya in 27-7-2013/archive.org>details>NJCL2015V2S1 (Retrieved on 15.10.2020)

between development on the one hand and the environment on the other. The objective of all laws on environment should be to create harmony between the two since neither one can be sacrificed at the altar of the other. Both development and environment must go hand in hand, in other words, there should not be development at the cost f environment and vice versa, but there should be development while taking due care and ensuring the protection of environment. Sustainable use of natural resources should essentially be based on maintaining a balance between development and the ecosystem. Coordinated efforts of all concerned would be required to solve the problem of ecological crisis and pollution. Unless we adopt approach of sustainable use, the problem of environmental degradation cannot be solved."

CONCLUSION

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There is no doubt that Sustainable Development is an integral part of our Constitution as well as the Inter-National Law and the provisions contained in the aforesaid principle are mandatory for all Nations of the World. The risk involved covers the entire humanity and the earth as well and the process is irreversible, which will ruin the Earth. Our Judiciary is very sensitive in this matter and it never tolerates any leniency in this regard. However, it is equally true that for the sake grant of total immunity to the nature, the development cannot be halted, but a balance has to be maintained, but this a great challenge to meet. It is true that Solar energy has no alternative and it has to continue despite endless adverse effects on humanity, nature, environment, ecology, ocean, ozone layer etc and the development of generating solar power cannot be halted at any rate. This problem has to be addressed by the experts and scientists in the field of Aerospace and let us hope and trust that one day or other the scientists and engineers of the specialized branch shall find out some solution to this problem, when both development of solar power system and sustainable development go hand in hand.

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